

in certain localities had 90 per cent of their number injured beyond recovery. Similarly in the case of chestnut, particularly chestnut coppice sprouts. Oaks were stripped of their branches. Yellow poplars of pole and standard size frequently broke squarely off below their crowns. Hickory was bent far over with interlocking limbs. Trees with twining vines were broken in two or borne down past recovery.

Had there been a heavy wind immediately following the storm the damage resulting would have been little short of disastrous. It is possible that where certain species, as the oaks, were broken off there may have been gusts of wind which increased the severity of the damage locally. Some of the trees which were merely bent over would have subsequently recovered, probably, if the sudden putting forth of the foliage a few weeks later had not held them down through sheer weight of the leaves. In support of this statement it was noticed by the forest officers in Pisgah Forest that many young trees which were borne down by the ice until their crowns were within a few feet of the ground, bent down after the coming of the leaves until their crowns touched the ground. Such trees can not now regain their former erect position.

In some of the large white pine groves on the private estates about Hendersonville and Flat Rock, N. C., the damage was also excessive. Although over a year has passed since the date of the storm, even now the men in charge of these estates have not been able to rid the groves and woodlands of the ragged appearance of the stands. The effects of the ice will be noticeable for a long time to come. Already the southern barkbeetle (*Dendroctonus frontalis*) has destroyed a large number of the pines. It may be reasonably anticipated that the injured hardwoods will more rapidly deteriorate through the action of fungi which may now find easy access to the interior of the trees.

The shattered tops in Pisgah Forest bear evidence of greater damage from natural causes than all the timber-felling crews would make in many years of careless cutting.

#### NOTE ON THE PRECEDING.

Mr. Rhoades describes very clearly the damage by ice to the timber in the vicinity of Hendersonville and Saluda, N. C. Unfortunately ice storms<sup>1</sup> of this kind are by no means infrequent in the Appalachians south of Pennsylvania. I have been struck in examining a great deal of the old forest, especially that of the mountain slopes between elevations of 1,200 and 4,000 feet, with the general prevalence of ice damage to the timber. In the mountains an ice storm is often limited to a belt or zone which may have an altitudinal range of only a few hundred feet, it being possibly so cold above this elevation that the rain falls as snow or hail, and so warm below it that there is no freezing; yet such a storm may extend for many miles along the mountains within this narrow belt.

Over certain sections, as on the Massanutten and Shenandoah Mountains in Virginia, the general appearance of the forest seems to indicate that practically all of it has been injured by ice during some period of its existence. It is frequently the case that ice damage occurred so many years ago that the trees have replaced their stripped crowns. There are several signs, however, which indicate that a forest has passed through such a crisis even though it may have been remote. In the

case of poplar, linn, cucumber, chestnut, and some other species having comparatively brittle wood, the stubs of the larger branches which were broken are tipped or even feathered with numerous small, mostly adventitious, branches. Oaks and hickories having tougher wood frequently have the entire upper portion of their crowns destroyed by the breaking of their central stems. The ultimate result of this is the development of very broad and flat mushroom-like crowns on trees which have been so mutilated. This form of crown is more lasting than the preceding and after a long period is a surer indication of ice damage. Stands have been examined in which the date of the storm, based on the estimated time of development of the mushroom crowns, was placed more than a hundred years ago. During this interval the branchy crowns of the chestnuts had nearly assumed a normal appearance. In many cases a shoot on a side, often on a nearly horizontal branch, develops into a new leader. In time a new crown of normal shape may form around this leader—but there will be an offset in the stem of the tree at the point of development of the new leader.<sup>1</sup>

Another and very lasting deformation, which takes place particularly in young stands which are so crowded that the stems are slender, is the bending over of the stems without breaking. Under the weight of ice the crowns of slender young hickories, even of trees 60 to 70 feet high, will sometimes touch the ground without the stems breaking. Such bent-over stems seldom right themselves, and since bending in this manner is practically limited to young trees the wood of which has not yet become brittle, it is an indication of ice damage which persists for a very long period. The presence in a stand of a number of old trees which are bowed in this manner is an almost certain sign of past ice damage of great antiquity. At the present time there is on Massanutten Mountain in Shenandoah County, Va., not a great distance from Woodstock, a young stand in which in many places the slender oaks and hickories, many of them 10 to 14 inches in diameter, have been bent into an almost inextricable tangle. On account of the youth of these trees comparatively few were broken. It is safe to say that the signs of this storm will be written in this stand for a century unless the injured trees are cut out.

As Mr. Rhoades states, the breakage by ice is a pre-disposing cause of diseased timber. It is in fact one of the causes of the large amount of wormy and fungous-infested timber of middle age which is to be found throughout certain sections. For this reason ice damage must be reckoned with as an important factor in developing any system of forest management in certain areas which are prone to such storms. Some of the windshake is also probably traceable to the trees bending or swaying under the stress of ice.

The recognition of ice injury of a distant past date in a stand is frequently extremely important in appraisal. The diseased condition of the tops and the wormy timber result in a material lowering of the grades of lumber below what would normally be looked for in trees having no other external indications of defect. Red oak along upper crests, which might otherwise be expected to cut out largely No. 1 common and better lumber, would contain an unaccountable proportion of sound wormy stock, a defect which is rather unusual for this species. Similar deterioration would take place in other species.—  
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<sup>1</sup> In June, 1917, in company with Mr. J. H. Fahrenbach, of the Forest Service, I noted the damage caused to timber along the Blue Ridge Mountains in Amherst County, Va., by a recent ice storm. It was not difficult to select trees which, through the development of such offset leaders, showed that they had been injured by two previous storms, which were apparently about 14 and 35 years before the last one.

<sup>1</sup> See article on "Definition of Sleet" in MONTHLY WEATHER REVIEW, May, 1916, 44: 281-286.